curves show the deviations of the semiannual means from it. In both figures the curves between twelve and fifteen hours and fifteen and eighteen hours are interpolated.

Figures 2 and 4 are copied from General Sabine's St. Helena Observations, vol. ii., and show the similarity between the movements of the magnet at Ascension and St. Helena.

The Tables annexed to this Paper are preserved for reference in the Archives.

*April* 22, 1869.

JOSEPH PRESTWICH, Esq., Vice-President, in the Chair.

Alphonse DeCandolle, of Geneva, Charles Eugène Delaunay, of Paris, and Louis Pasteur, of Paris, were proposed for election as Foreign Members, and notice was given from the Chair that these gentlemen would be ballotted for at the next Meeting.

The following communications were read :—

I. "Description of *Parkeria* and *Loftusia*, two gigantic Types of Arenaceous Foraminifera." By Dr. Carpenter, V.P.R.S., and H. B. Brady, F.L.S. Received March 18, 1869.

(Abstract.)

The Authors of this Memoir commence by referring to the separation of the series of *Arenaceous* Foraminifera from the *Imperforate* or *Porcellanous*, and from the *Tubular* or *Vitreous*, first distinctly propounded in Dr. Carpenter's 'Introduction to the Study of the Foraminifera' (1862), on the basis of the special researches of Messrs. Parker and Rupert Jones; who had pointed out that whilst there are several genera in some forms of which a cementation of sand-grains into the substance of the calcareous shell is a common occurrence, there are certain genera in which a "test" formed entirely of an aggregation of sand-grains takes the place of a calcareous shell; and that these genera constitute a distinct Family, to which important additions might probably be made by further research.

The propriety of this separation of the *Arenacea* from the calcareous-shelled Foraminifera has been fully recognized by Prof. Reuss, the highest Continental authority upon the group; who had come to accept the principle laid down in Dr. Carpenter's successive Memoirs (Phil. Trans. 1856–1860), that the *texture of the shell* is a character of fundamental importance in the classification of this group, the *plan of growth* (taken by M. d'Orbigny as his primary character) being of very subordinate value; and who had, on this basis, independently worked out a Systematic Arrangement of the entire group, which presents a most remarkable correspondence with that propounded by Dr. Carpenter and his coadjutors. And their anticipation of important additions to the Arenaceous series has

been fully borne out, on the one hand by the discovery of several most remarkable new forms at present existing at great depths in the Ocean, which has been made by the dredgings of M. Sars, Jun., and those of the 'Lightning' Expedition, and on the other by the determination of the real characters of two fossils, one of the Cretaceous, and the other probably of the earlier Tertiary period, which prove to be gigantic examples of the same type.

The first of these, discovered by Prof. Morris more than twenty years ago in the Upper Greensand near Cambridge, was long supposed to be a Sponge; but his more recent discovery of two specimens which had been but little changed by fossilization, led him to suspect their Foraminiferal character; and this suspicion has been fully confirmed by the careful examination made of their structure by Dr. Carpenter, to whom he committed the inquiry, and by whom, with his concurrence, the name *Parkeria* was assigned to the genus. The second, which was obtained by the late Mr. W. K. Loftus from "a hard rock of blue marly limestone" between the N.E. corner of the Persian Gulf and Ispahan, bears so strong a resemblance in its general form and mode of increase to the genus *Alveolina*, that its Foraminiferal character was from the first recognized by the discoverer; but as all the specimens brought by Mr. Loftus had undergone considerable alteration by fossilization, their minute structure, though carefully studied by means of transparent sections, could not in the first instance be satisfactorily made out. When, however, Dr. Carpenter's investigation of *Parkeria*, with the full advantage of specimens but little changed by fossilization, revealed the very remarkable plan of its structure, the investigation of this type was resumed by Mr. Brady (who assigned to it the name *Loftusia*), with the new light thence derived: for as transparent sections of infiltrated *Parkeriæ* furnish a middle term of comparison between specimens of the same type which retain their original character, and transparent sections of infiltrated *Loftusiæ*, the last-mentioned can now be interpreted by reference to the preceding; so that the obscurities which previously hung over their minute structure have been almost entirely dissipated.—The description of the structure of *Parkeria* in this Memoir is by Dr. Carpenter, and that of the structure of *Loftusia* by Mr. H. B. Brady; but each has gone over the work of the other, and can testify to its correctness.

The specimens of *Parkeria* which have been collected by Prof. Morris* are spheres varying in diameter from about 3-4ths of an inch to about $1\frac{1}{4}$

* Since this Memoir was completed, the Author has learned that Mr. Harry Seeley, of Cambridge, has collected several specimens of this type, and has been studying it independently with a view to publication. And Mr. Henry Woodward has placed in his hands a specimen from the Upper Greensand in the Isle of Wight, which is not less than $2\frac{1}{4}$ inches in diameter. It is interesting to remark that the "nucleus" of a smaller specimen from the same locality consists of a considerable number of chambers arranged in a *spire*, the structure of its concentric spherical layers being exactly the same as in the specimens described in the text.

inch. The character of their external surface differs considerably in different individuals; but the Author gives reason for believing that it was originally tuberculated, like a mulberry, and that the departures from this have been the result of subsequent abrasion. The entire sphere is composed of a great number of concentric layers, all of which, except the innermost, are arranged with very considerable regularity around a central "nucleus," which consists of five chambers, disposed in *rectilineal* sequence, thus unmistakeably indicating the Foraminiferal character of the organism, which might otherwise have remained in doubt, on account of the entire divergence from any known type presented in the structure of the concentric layers. The first of these layers is moulded (as it were) on the exterior of the nucleus, and partakes of its elongated form; but the parts of every additional exogenous layer are so arranged as to bring about a gradual approximation to the spherical form, which is afterwards maintained with great constancy. Each layer may be described as consisting of a lamella of "labyrinthic structure" (that is, of an assemblage of minute chamberlets, whose cavities communicate freely with one another), separated from the contiguous lamellæ by an "interspace," which is traversed by "radial tubes," that pass from each lamella to the one external to it. All these structures, in common with the chamber-walls and septa of the "nucleus," are built up by the *aggregation of sand-grains of very uniform size*. These sand-grains are found to consist of *Phosphate of lime*; and they seem to be united by a cement composed of *Carbonate of lime*, which was probably exuded by the animal itself. Although there is a very general uniformity in the thickness of the successive layers, the proportion of their several components varies considerably in different parts of the sphere. In those which immediately surround the nucleus, the solid lamellæ, which are composed of labyrinthic structure, are comparatively thin; whilst the interspaces which separate them from one another are very broad, so that the radial tubes which traverse these interspaces are very conspicuous. As we pass outwards, we find the labyrinthic lamellæ increasing in thickness, whilst the breadth of the interspaces diminishes in the same degree, until we meet with layers in which the interspaces are almost entirely replaced by labyrinthic structure. With this increased development of the labyrinthic structure in the concentric lamellæ themselves, we find it extending between one lamella and another, as an investment to the radial tubes; thus forming "radial processes" of a subconical form, which occupy a considerable part of what would otherwise be the interspaces between the successive lamellæ. Still every lamella is separated from that which invests it (except where brought into connexion with it by its radial processes) by a system of cavities, which are in free communication with each other, and which may be collectively designated the "interspace-system;" and from this system the labyrinthic structure of the investing lamella is entirely cut off by an impervious wall, which bounds it upon its *inner* side; whilst its chamberlets open freely upon

the *outer* side of the lamella, into what, when it is newly formed, is the surrounding medium, but, when it has itself been invested by another layer, into its "interspace-system."—In the larger of the two non-infiltrated specimens which have furnished the materials for the present description, the number of concentric layers is 40, and their average breadth about 1-65th of an inch.

The Author discusses the mode in which this composite structure was formed; and comes to the conclusion that the production of each new layer was probably accomplished by the instrumentality of the sarcodic substance, which not only filled the chamberlets of the preceding layer, but projected beyond it; that the radial processes were first built up like the columns of a Gothic cathedral, and that their impervious investing wall spread itself from their summits, so as to form a continuous lamella over the sarcodic layer, in the manner that the summits of such columns extend themselves to form the arched roof of the edifice; and that on the floor of the new layer thus laid the partitions of the chamberlets were progressively built up by the agency of the sarcodic substance conveyed to the outer surface of that floor through the radial tubes. The author further argues, from the analogy of living *Foraminifera*, that notwithstanding the indirectness of the communication between the cavitary system of the inner layers and the external surface, the whole of that system (consisting of the labyrinthic structure of the successive lamellæ, and of the interspaces which separate them) was occupied during the life of the animal by its sarcode-body.

The *plan of growth* in *Loftusia* is stated by Mr. Brady to differ extremely from that of *Parkeria*, whilst its *intimate structure*, on which its physiological condition must have depended, is essentially the same; thus affording a conspicuous example of the validity of the principle of Classification already referred to. This difference is indicated by its shape, which closely resembles that of many *Alveolinæ* and *Fusulinæ*; being a long oval, frequently tapering almost to a point at either end, though sometimes obtusely rounded at its extremities. Of two large and perfect examples in the collection of the late Mr. Loftus, one measures $3\frac{1}{4}$ inches by 1 inch, the other $2\frac{1}{4}$ inches by $1\frac{1}{4}$ inch. A transverse section at once indicates that the plan of growth is a spiral, formed by the winding of a continuous lamina around an elongated axis; the general disposition of the chambered structure being very similar to that which would be produced if one of the simple *Rotalians* were thickened and drawn out at the umbilici. The space inclosed by the *primary lamina* is divided into chambers by longitudinal septa, which may be regarded as ingrowths from it, extending, not perpendicularly (as in *Alveolina*), but very obliquely. The chambers, separated by these principal or *secondary* septa, are long and very narrow, and extend from one end of the body to the other. Their cavities are further divided into chamberlets by *tertiary* ingrowths, which are gene-

rally at right angles to the septa or nearly so, but are otherwise irregular in their arrangement. No large primordial chamber, such as is common among Foraminifera, has been yet discovered in *Loftusia*; but its absence cannot be certainly affirmed. In fully grown specimens the turns of the spire, which succeed each other with tolerable regularity at intervals of from 1-50th to 1-30th of an inch, are usually from twelve to twenty in number; but as many as twenty-five have been counted in one instance, and a yet larger number might not improbably be met with. The *spiral lamina* and its prolongations, forming the accessory skeleton, are all constructed of almost impalpable grains of sand, which is proved by analysis to have consisted of *Carbonate of Lime*, united by a cement of the same material.

The Author then describes in detail the several components of the fabric of *Loftusia*, and compares them with the corresponding parts of *Parkeria*. The continuity of increase of the spiral lamina always leaves an open fissure between its last-formed margin and the surface of the previous whorl; and through this aperture the whole system of chambers included within its successive laminæ communicates with the exterior, through the passages between their cavities, which are left in the building up of the septa. As already explained, the labyrinthic structure takes its origin from the *inner* surface of the impervious spiral lamina, the septa being directed towards the central axis. These ingrowths have in many instances the form of tubular columns, which traverse the chambers in a radial direction (*i. e.* perpendicular to the spiral lamina), terminating either on the septum of the previous chamber, or on the exterior wall of the preceding whorl of chambers. But these tubes do not seem to be homologous with the "radial tubes" of *Parkeria*, whose relations differ in important particulars. The range of variation in a number of specimens, as to the amount of the "secondary" and "tertiary" ingrowths which divide and subdivide the chambers in *Loftusia* is very great. The principal office fulfilled by this accessory skeleton seems to be that of a support to the primary spiral lamina, imparting the necessary solidity to the organism. The degree of subdivision of the chambers into chamberlets seems to have little bearing on the general economy of the animal.

The Author attempts to determine from the other Foraminifera, of which the remains are found associated in the same Limestone with those of *Loftusia*, what was its probable Geological age, and under what conditions it was deposited; and he thence draws the conclusion that the rock belongs to the lowest portion of the Tertiary period, presenting a microzoic Fauna very similar to that of some of our Miliolite Limestones, but richer in the small arenaceous *Rhizopods*; and that the sea-bottom was a soft Calcareous mud lying at a depth of from 90 to 100 fathoms.